

AMENDMENTS TO THE SPECIFICATION:

Please replace the paragraph beginning at page 3, line 7, with the following rewritten paragraph:

-- Surprisingly, it has been found that a calcium based cement system comprising phosphate, at a boundary or a gap between a tooth or a bone and a dental filling material and an implant material, respectively, not only provides for the formation of a chemically bonded ceramic composite comprising apatite, but also leads to a faster healing of the tooth or the bone. It has been found that a chemical and biological integration takes place, that leads to an additional surface growth that chemically diminishes the gap between the tooth/bone and the dental filling material/implant material, but that also, due to the presence of apatite, will result in a faster biological sealing of the gap. The healing or growing process of the bone or the tooth is favoured by the supply of calcium and ~~phosphor~~ phosphorous from the cement system.--

Please replace the paragraph beginning at page 3, line 24, with the following rewritten paragraph:

-- Another aspect of the formation of hydroxyapatite (formation of HAP) in connection with the general mechanism at hardening comprising dissolving and depositing, is that the system may act to favour healing at attacks on tooth or bone tissue. Hereby, the biological material that has lost its hard

material (its biologically formed apatite) is remineralised by Ca-aluminate with a source of ~~phosphor~~ phosphorous reacting with water of body fluid. The material is dissolved, i.e. becomes a solution and ions such as calcium, aluminate, phosphate, hydroxyl and optional additives, such as fluoride, is deposited in all voids, including those coming from previous bone decay. This means that also caries that unintentionally has been left after treatment, can be remineralised. Also other bone materials can be favoured in healing in a corresponding manner, e.g. related to osteoporosis etc.-

Please replace the paragraph beginning at page 3, line 36, with the following rewritten paragraph:

-- At attacks of caries or other bone decay, the surface may therefore be pre-treated by a cement system that contains a lot of calcium and ~~phosphor~~ phosphorous, in order to facilitate a fast and efficient formation of materials containing HAP. One concept is that the hydration liquid contains phosphoric acid with tricalcium phosphate and that the binder phase of the cement essentially consists of fine grain ($< 5 \mu\text{m}$, preferably $< 1 \mu\text{m}$ grain size) of C_3A (i.e. $3\text{CaO} \bullet \text{Al}_2\text{O}_3$) and/or C_3S (i.e. $3\text{CaO} \bullet \text{SiO}_2$) and/or C_2S (i.e. $2\text{CaO} \bullet \text{SiO}_2$).-

Please replace the paragraph beginning at page 4, line 6, with the following rewritten paragraph:

--As to the coating of implants, the integration with the bone may be improved and accelerated by:

1. HAP being brought to constitute a part of a coating of CAH-HAP on an implant of metal, ceramics or polymer. The coating being produced and hydrated before implantation.
2. Accelerated/increased formation of HAP after implantation, by an outermost layer having been applied onto the coating by extra addition of non-reacted CA + phosphate. The surface layer may contain a source of ~~phosphor~~ phosphorous or the surface may be steeped in a phosphate-containing aqueous solution.
Effect: Additional surface growth chemically diminishes the gap, and a faster biological sealing of the gap takes place due to presence of HAP. See also the drawings description.--

Please replace the paragraph beginning at page 4, line 19, with the following rewritten paragraph:

-- Another way of achieving non-reacted material in the outermost part of the coating, is to:

3. Apply a torque on the coating just before or in connection with the implantation. The surface layer may contain a source of ~~phosphor~~ phosphorous or the surface

may be steeped in a phosphate-containing aqueous solution.

Effect: Releases non-reacted material

CAH = the calcium aluminate system

CA = calcium aluminate, raw material without water/hydration
liquid

HAP = hydroxyapatite--

Please replace the paragraph beginning at page 5, line 20, and bridging pages 6 and 7, line 13, with the following rewritten paragraph:

-- In addition:

- a. Said water soluble phosphate may consist of a water soluble, phosphate containing phase, alkali phosphates e.g. For the bonding system especially, the content of phosphate is suitably high, preferably 1-90 %, more preferred 5-60 % and even more preferred 10-30 %.

Effect: an increase of the phosphate content in the material will result in an increased content of apatite (not only limited to the phosphate content of the solution).

- b. The material may comprise grains of phosphate-containing phase, preferably hydroxyapatite and fluoride-apatite, Effect: controlling the precipitation of apatite.

- c. The material may comprise additives of collagen, elastin or other high-molecular proteins that are coated in-situ or

are pre-coated by apatite, from a saturated solution.
Effect: to control the deposition of apatite.

d. The material may comprise an additive of a fluoride-containing phase of non difficultly soluble character, fluoride-containing glass (glass ionomer glass) e.g. of non difficultly soluble character, at contents below 10 %. Other examples of fluoride-containing phase are calcium fluoride (CaF_2) or sodium fluoride (NaF).
Effect: a way of introducing fluoride in the material, whereby fluoride-apatite can be formed.

e. In the bonding system, the binder phase suitably has a larger mole content of calcium than of aluminium, in which case the binder phase preferably comprises or essentially consists of $3\text{CaO} \cdot \text{Al}_2\text{O}_3$ (C3A). Accordingly, the ceramic powder is preferably modified for an increased Ca-content in aluminate (the C₃A-CA-system). If using C3A or some other phase that is rich in calcium, more calcium is obtained that can react with ~~phosphor~~ phosphorous to form apatite. In addition, C3A hardens fast which is good in a thin layer that is to be applied onto the tooth/bone before the filling takes place.

f. The material may comprise carbonate or biologically existing ions that may form: oxalates, lactates, calcite, aragonite. Carbonate ions may for example form calcite and calcium may form difficultly soluble biological salts with

the anion of the lactic acid, lactate etc.
Effect: by controlling the concentration and the composition of the ions, different biological phases containing Ca may be deposited. This also applies to water-soluble additives in the powder raw material.

- g. The addition of water-soluble phosphate may be achieved by addition of a phase that forms phosphate ions during hydration (P_2O_5 , active glass containing ~~phosphor~~ phosphorous, bioglass, Apatite-Wollastonite glass e.g.). Additives of elements that deliver phosphate in water, such as tricalcium phosphate, alkali salts, are also included in the concept of "addition of water-soluble phosphate".
- h. It is also possible to supply ~~phosphor~~ phosphorous by pre-coating particles (filler or cement) with phosphate or ~~phosphor~~ phosphorous. Such a pre-coating may easily be performed by dissolving crystals of phosphoric acid e.g. in an inert solvent, isopropanol e.g. Fillers and cement particles are then mixed in the isopropanol, where after the isopropanol is driven off and ~~phosphate/phosphor~~ phosphate/phosphorous remains on the particles.
- i. It is also possible to form solid solutions of cement phase (calcium silicates or calcium aluminates) and ~~phosphor~~ phosphorous, according to the principles described in SE-A0-0103189-7. The concentration of ~~phosphor~~ phosphorous

that is possible to dissolve in the cement is $< 10\%$ by atoms, preferably $< 5\%$ by atoms.

- j. Also other apatites than hydroxyapatite and that function well in the body, can be included in the concept of "apatite" and may in the present text also be included in the concept of "hydroxyapatite", chloride-apatite, carbonate apatite, fluoride-apatite and magnesium apatite e.g. Chloride-apatite may easily be formed by dissolving chloride in the hydration liquid or alternatively by incorporating a readily soluble salt in the material. Carbonate apatite may be formed by hydrating in carbonated phosphoric acid. Fluoride-apatite may be formed by addition of fluoride, in the form of LiF e.g. as an accelerator and magnesium apatite may be formed by precipitation reaction at the forming of apatite with Mg in the aqueous solution.
- k. For dental filling or implant materials, the powdered material may take the form of a raw compact that preferably exhibits a degree of compaction of at least 55% by volume solid phase, more preferred at least 60% by volume solid phase, even more preferred at least 65% by volume solid phase and most preferred of all at least 70% by volume solid phase.
- l. As an alternative, the powdered material may exist in loose powder form, in which case it is mixed with the hydration

liquid to form a suspension that is subsequently drained and compacted.--

Please replace the paragraph beginning at page 7, line 15, with the following rewritten paragraph:

-- It is especially preferred that the main binder phase of the cement system consists of calcium aluminate (Ca-aluminate), since:

1. Ca-aluminates will give a basic local environment for the apatite, which makes that phase stable (no dissolution, preventing formation of plaque and lactic acid).
2. Ca-aluminate exists in surplus and is formed in all pores in the material - contributes to fill the material - if only apatite was used, too little water would be transformed in order for water-filled porosity to be filled by hydrate.
3. Ca-aluminate is deposited by acid-base reaction, in which water reacts with the powdered material, that starts to dissolve. In the solution, all constituents exist that are needed for the formation of both calcium aluminate hydrate, gibbsite and apatite (if some type of ~~phosphor~~ phosphorous is supplied) and possibly some other biologically favourable phase (calcite, aragonite, lactate etc.). When the solubility product of each substance is reached, a deposition starts to take place. The deposition takes place

everywhere, including inside the micro-spaces between the filling material and the tooth wall. Small crystals are deposited in the surface topography in the tooth wall or some other biological contact surface and contributes to the complete disappearance of the contact zone of filling material-tooth/bone, leading to micro-structural integration. No gap can be discovered in magnifications of up to 20,000 times.--

Please replace the paragraph beginning at page 8, line 14, with the following rewritten paragraph:

--In addition:

- a) Said water soluble phosphate forms phosphate ions in the liquid, preferably PO_4^{3-} , HPO_4^{2-} , H_2PO_4^- or some other ~~phosphor-containing~~ phosphorous-containing ion.
- b) The liquid may also be a bonding liquid, that is applied on bone or tooth before the dental filling material/implant material with additional (free from phosphate or phosphate-containing) hydration liquid is applied, in which case water soluble phosphate in the bonding liquid forms apatite with the dental filling material/implant material.
- c) The liquid may comprise carbonate or biologically existing ions that may form: oxalates, lactates, calcite, aragonite. Carbonate ions may for example

form calcite and calcium may form difficultly soluble biological salts with the anion of the lactic acid, lactate etc.

Effect: by controlling the concentration and the composition of the ions, different biological phases containing Ca may be deposited.

d) The concentration of phosphate ions should be 0.01-5 M, preferably 0.1-2 M and most preferred 0.5-1.5 M. Specifically for the bonding system, the preferred concentrations are even higher, namely 0.01-5 M, preferably 0.5-4 M, most preferred 1-3 M. Suitably, phosphate ions exist in concentrations close to saturation in the bonding liquid or the liquid for the bonding system. By using very high concentrations, an increased deposition of apatite may be obtained in the zone between the tooth/bone and the material. Effect: A high concentration will give more apatite phase.

e) The pH should be adjusted to at least 7, preferably 7-12.5 and even more preferred 7-11, Effect: The pH controls the equilibrium for deposition of apatite and katoite (main phase in the Ca-aluminate-hydrate system).

f) The liquid may comprise added fluoride ions, to a concentration of fluoride ions in the range of 0.01-5

M, preferably 0.1-2 M, most preferred 0.5-1 M,
Effect: gives a formation of fluoride-apatite,
together with katoite. (Fluoride-apatite is even more
stable than hydroxyapatite).

- g) The liquid may comprise a suspended or emulsified, non hydrated or partially hydrated calcium aluminate cement, for the formation of a basic environment for the apatite.
- h) The liquid may comprise accelerator and/or superplasticizer.
- i) Chloride-apatite may be formed by dissolving chlorine in the hydration liquid. Carbonate apatite may be formed by hydrating in carbonated phosphoric acid. Fluoride-apatite may be formed by addition of fluoride, in the form of LiF e.g. as an accelerator and magnesium apatite may be formed by precipitation reaction at the forming of apatite with Mg in the aqueous solution.--